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AUTHOR	Fenske, Robert H.; Porter, John D.; DuBrock, Caryl P.
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ABSTRACT

This study examined the persistence of and financial aid to needy students, underrepresented minority students, and women students, especially those majoring in science, engineering, and mathematics at a large public research university. An institutional student tracking and student financial aid database was used to follow four freshmen cohorts (n=7,164) from 1989-90 through 1996-97. Findings indicated lower departure rates for students in science, engineering, and mathematics than for their counterparts in nonscientific fields. However, science majors also spent more years enrolled and graduated at slower rates than did nonscientific majors. White, Asian, and female students in science, engineering, and mathematics graduated at faster rates and were less likely to leave the institution than were underrepresented minorities and needy students. Underrepresented minorities in all majors were more likely to receive financial aid packages that combined both gift and self-help than nonminorities. Significant differences in re-enrollment by type of aid package received were observed in the first two years, with "gift aid only" packages associated with greater retention. An increasing trend identified in financial aid packaging for non-needy students was toward increasing the gift-aid dollars for the first two years with more borrowing in later years. (Contains 35 references.) (DB)

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Analyzing Student Aid Packaging to Improve Low-Income and Minority Student Access, Retention and Degree Completion

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By

Robert H. Fenske
Professor of Higher Education
Arizona State University
P.O. Box 872411, Tempe, Arizona 85287-2411
480-965-5327
< robert.fenske@asu.edu >

John D. Porter
Director of the Office of Institutional Analysis
and Data Administration
Arizona State University
P.O. Box 871203, Tempe, Arizona 85287-1203
480-965-5959
< john.porter@asu.edu >

Caryl P. DuBrock
Graduate Research Assistant
Arizona State University
P.O. Box 871203, Tempe, Arizona 85287-1203
480-965-1562
< caryl.dubrock@asu.edu >

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Dolores Vura
Editor
Air Forum Publications

Analyzing Student Aid Packaging to Improve Low-Income and Minority Student Access, Retention and Degree Completion

Abstract

This research focuses on the persistence and financial aid of needy students, underrepresented minority students and women students, especially those majoring in science, engineering and mathematics. To conduct this research, an institutional student tracking and student financial aid database was developed utilizing data warehousing technology. Starting in 1989-90, four freshmen cohorts (N=7164) at a public research university were tracked through 1996-97.

This study reports lower departure rates for all science, engineering and mathematics study populations compared to their counterparts in nonscientific fields. Research results, however, indicate that they spend more years enrolled and graduate at a slower rate than nonscientific majors. In science, engineering and mathematics, White, Asian and female students not only graduate at a faster rate but underrepresented minorities and needy students experience the largest departure rates. Underrepresented minorities of all majors are most likely to receive financial aid packages containing both gift and self-help aid. Significant differences in re-enrollment by type of aid package received were observed in the earlier years with gift aid only packages being associated more with retention. Increasing gift aid dollars in the packages for the first two years especially for non-needy students and more borrowing in the later years were identified as prevailing trends.

Analyzing Student Aid Packaging to Improve Low-Income and Minority Student Access, Retention and Degree Completion

This study explores the financial aid and academic progress of underrepresented minority students, women students, and needy students, especially those majoring in science, engineering, and mathematics. The longer-term objective of this research is to compare institutional longitudinal data to national longitudinal data for beginning postsecondary students.

Access, cost and financing higher education are critical issues in higher education today with students, their parents, and the federal and state governments. The issue of access has not dissipated in great part due to the escalating costs of education and federal financial aid policies shifting from gift aid to self-help aid available to all, regardless of need (e.g., Fenske & Gregory, 1994; Fenske, Porter & Dillon, 1997). At the same time, rising costs contribute to demands for more accountability from institutions of higher education. Access, controlling costs and educating tomorrow's workforce are the fundamental challenges facing higher education.

Educating tomorrow's workforce includes meeting the technical labor force needs of the nation. An important part of this goal is increasing the numbers of women and underrepresented minorities participating in science, engineering and mathematics. In the 1994 Goals 2000 Act, Congress placed special emphasis on underrepresented students by stating "the number of United States undergraduate and graduate students, especially women and minorities, who complete degrees in mathematics, science and engineering will increase significantly" (section 102, 5Biii). To increase the numbers of women and underrepresented minorities in science, engineering and mathematics, economic status must not be a barrier to access, retention and degree completion in higher education. Financial aid policy and programs are the primary vehicles to ensure economic status is not a barrier.

Review of Literature

Although there are numerous reports documenting the shortage of women and underrepresented minorities graduating in science, engineering and mathematics, there are far fewer studies investigating the retention of these populations. When the dimension of student financial aid is added, there is an almost total lack of definitive research.

Research on Special Student Populations in Science, Engineering and Mathematics

Several studies have shown that science, engineering and math majors have greater persistence and graduation rates than the total student population rates (e.g., Brewton & Hurst, 1984). Yet, these higher rates are not shared by women and underrepresented minorities in science and engineering (e.g., Government-University-Industry Research Roundtable, 1987; Strenta, Elliott, Adair, Matier & Scott, 1994). The majority of the research on the lower persistence of women and underrepresented minorities in science, engineering and math has focused on aspects such as: inadequate academic preparation (Elliott, Strenta, Adair, Matier & Scott, 1995; Strenta et. al., 1994; National Science Foundation [NSF], 1994); math anxiety or avoidance (Rendon, 1982); the role of language on cognitive processes (Mestre, 1986); the lack of faculty role models (Regional Policy Committee on Minorities in Higher Education, 1987; NSF, 1996); pedagogy (NSF, 1994; Strenta et. al., 1994); and poor academic and social integration experiences (Steele, 1995).

It is widely recognized that financial aid is critical to underrepresented populations majoring in science, engineering and math fields. The National Action Council for Minorities in Engineering (Landis, 1985) states availability of adequate financial resources is among the top five factors related to minority persistence in engineering. Rendon and Triana's study of the barriers to Hispanic students in math and science reports "financial aid is critical for most Hispanic students who need to be enrolled full time and devote full attention to their studies"

(1989, p. 18). Similar findings are found in Gardner and Broadus' study of entering engineering students at a large, public midwestern university (1990). They report Black students worked twice as many hours as White students to finance their education and study time suffered as a result.

In its 1996 report on women and minorities in science and engineering, NSF notes the lack of longitudinal data on these populations (p. 34). Cross-sectional surveys only provide limited insight into persistence and financial aid issues. NSF's National Survey of Recent College Graduates collects self-reported data on the sources graduates used to finance their undergraduate education. NSF (1997) reports that science and engineering graduates rely on gifts from family (74.1 percent of the respondents) followed by employment (68.3 percent), gift aid (55.8 percent) and loans (48.0 percent). This data, however, fails to increase the understanding of the impact financial aid has on the persistence and graduation of particular student populations.

Research on Financial Aid and Special Student Populations

Numerous researchers have studied the financial aid received by underrepresented students in all fields of higher education. In Cibik and Chambers' 1991 study of the barriers to academic success, finances and the availability of financial aid were determined to be "first-order concerns" of Hispanics, Blacks and Native Americans. Mortenson (1989) found women and Hispanics were less likely to have favorable attitudes toward educational loans. This data, however, showed no difference in the attitudes about loans for Blacks and Whites. First year financial aid awards by ethnicity for the 1989-90 Beginning Postsecondary Student (BPS) survey cohort reveals Black and Native American students were most likely to receive aid especially in the form of grants (National Center for Education Statistics [NCES], 1995). Black students also

were most likely to receive loan aid. Both Olivas (1985) and Nora (1990) found that Hispanics had a "extraordinary reliance" on Pell grants although Nora reports other noncampus- and campus-based aid are significant in retention. In 1989, St. John and Noell examined the effects of the type of aid offered to Whites, Blacks and Hispanics on their enrollment decisions. They found that all types of aid had a positive influence on enrollment by college applicants regardless of race or ethnicity. Other studies have indicated that minorities often avoid loans and when loans are used, persistence can be negatively impacted (Astin and Cross, 1979; Astin, 1982; Thomas, 1986). Porter's 1986 work found first year minorities participated in more types of aid, relied less on loans and received more gift aid dollars than their majority counterparts. He also reported that the type of package received by minority students in their first year was very important but not in the second year.

Purpose of the Study

The primary focus of this research is the persistence patterns and student financial aid received by needy students, underrepresented minority students (American Indians, Blacks and Hispanics) and women students, especially those majoring in science, engineering and mathematics. The success of the study groups is viewed in relation to other cohorts in the university, both within science, engineering and mathematics and outside these subject areas. In order to conduct the research, a student tracking and financial aid data warehouse was developed at a large, public university. This warehouse is based on relational database technology and the data model and process for building similar databases are available to other institutions.

The research questions are as follows:

- What are the persistence patterns of the study groups compared to their peers?
- Are the students in the study groups financing higher education differently than their peers?

- Is there a significant difference in the persistence status of the study groups based on the type of aid package?
- Have the amounts and types of aid of the targeted study groups changed over time compared to more affluent students, nonminority students, and male students?

Project Design

A key component of this project involved the design and development of a relational database for tracking student academic progress and financial aid. The Financial Aid and Academic Progress (FAAP) database includes nine fall cohorts of new undergraduate students (including transfers) starting in fall 1989. There are 83,499 student characteristic records (including demographic and educational background data), 396,532 term enrollment records (including registered hours, declared major, withdrawal hours, GPA and probation status), and more than 1.6 million course records. For studies focusing on transfer and "swirling" students, a transfer table incorporates 115,672 transfer records by institution and student ID.

A focal point of the FAAP database is the inclusion of student financial aid data. Annual aid records, numbering 139,240, include totals of aid by type and classify the overall financial aid package. Individual award financial details also are available for the 308,089 aid awards from 1989-90 through 1996-97. A financial aid fund code table containing 3,357 institutional codes is used to identify individual financial aid programs and classify each according to type of award, source of funds and award basis (need, academic merit, leadership, etc.)

This institutional database has been designed to closely parallel BPS, a national longitudinal database. Therefore, FAAP is a powerful tool both for institutional analysis and decision making, as well as longitudinal student research comparing institutional and national trends.

Study Population and Research Design

The study cohorts were drawn from the enrollment records of a large public research university in a metropolitan area. The institution attracts many kinds of students including first-time, transfer, re-entry, nontraditional, and commuting students as well as students from all socioeconomic strata. Over the study period (1989-90 to 1996-97), the student headcount and the number of undergraduate students, first-time freshmen and full-time undergraduates remained fairly constant. The percentage of minority undergraduates, however, increased 6.5 percent. Large increases in financial aid also are noted. In 1989-90, over 50 percent of all students (undergraduate and graduate) received some form of student financial assistance. The average award in 1989-90 was $4,257. By 1996-97, over 70 percent of all students received financial aid and the average award jumped 76 percent to $7,509.

Study Years. Although the FAAP database includes nine first-time, fall cohorts, this study focuses on cohorts that have at least five years of persistence and financial aid data. The study cohorts are the fall 1989 cohort (followed eight years), fall 1990 (followed seven years), fall 1991 (followed six years), and fall 1992 (followed five years).

Cohort Definition and Primary Classification. Each study cohort is limited to resident, degree-seeking, first-time freshman at the university. To parallel BPS, both traditional and nontraditional students are included in the institutional cohorts. The primary classification is on the basis of the declared major the first term attended. Those majoring in science, engineering and math (SEM), as defined by NSF are separated from those majoring in all other fields. The scientific majors include: (1) engineering, (2) math and computer science, (3) physical sciences, and (4) social and behavioral sciences.

Secondary Classifications. Additional classifications of the cohorts were made on the basis of gender, minority status and the type of aid (as a surrogate measure of family income status). At the institutional level, family income data is usually available only for students applying for financial aid. Therefore, institutional-based studies often must rely on financial aid need calculations or the receipt of federal need-based aid as a surrogate measure for low-income status.

Sample Sizes. Classifying the study population in this manner results in 16 groupings per cohort and 64 study populations for the four entering cohorts (1989-1992). The sample size for each special population is reported in Table 1.

Table 1 Cohort Size and Distribution by Special Populations

	1989 Cohort n=1967		1990 Cohort n=1679		1991 Cohort n=1614		1992 Cohort n=1924	
	n	%	n	%	n	%	n	%
SEM Majors	519	26.4	450	26.8	346	21.4	432	22.5
Female	207	39.9	196	43.6	137	39.6	159	36.8
Male	312	60.1	254	56.4	209	60.4	273	63.2
Minority	95	18.3	89	19.8	73	21.1	128	29.6
White or Asian	424	81.7	361	80.2	273	78.9	304	70.4
Aided with Need	164	31.6	149	33.1	99	28.6	155	35.9
Aided, No Need	155	29.9	145	32.2	144	41.6	167	38.7
Non-aided	200	38.5	156	34.7	103	29.8	110	25.5
Nonscientific Majors	1448	73.6	1229	73.2	1268	78.6	1492	77.5
Female	797	55.0	678	55.2	720	56.8	867	58.1
Male	651	45.0	551	44.8	548	43.2	625	41.9
Minority	246	17.0	259	21.1	240	18.9	300	20.1
White or Asian	1202	83.0	970	78.9	1028	81.1	1192	79.9
Aided with Need	390	26.9	367	29.9	371	29.3	510	34.2
Aided, No Need	392	27.1	371	30.2	393	31.0	414	27.7
Non-aided	666	46.0	491	40.0	504	39.7	568	38.1

Methodology and Measurements. This project is a descriptive longitudinal retention study using quantitative institutional measures. Data were extracted from FAAP and exported to

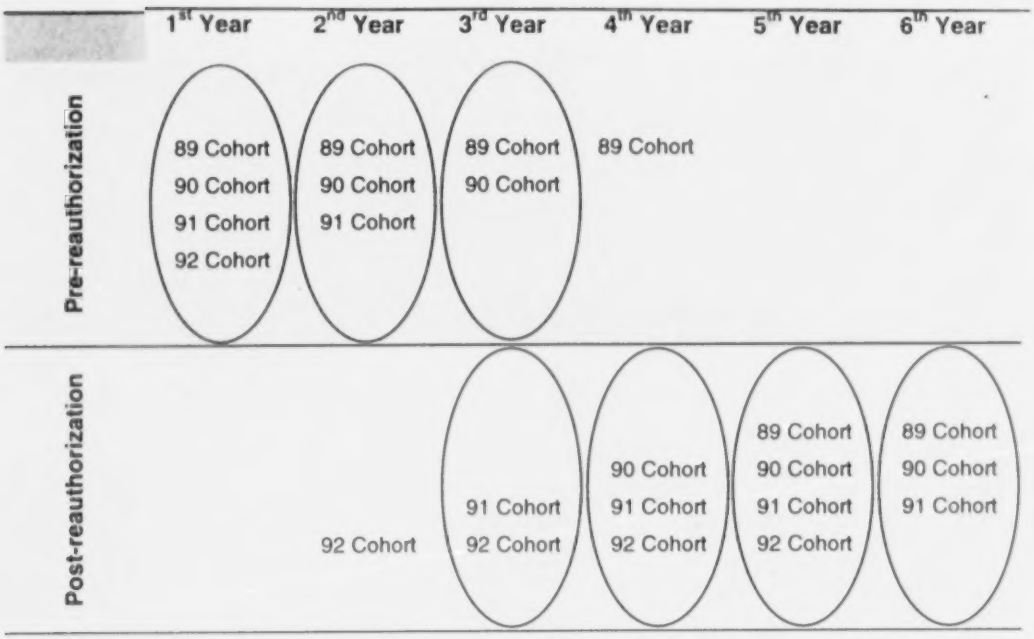
SPSS 8.0 for Windows. Using SPSS, enrollment status and financial aid status for each year were generated. Enrollment data by term and financial aid data by fiscal year were transformed into year of enrollment since entering (e.g., 1991-92 data on the 1989-90 cohort became third year enrollment and aid data while 1991-92 data on the 1991-92 cohort became first year enrollment and aid data). The statistical analysis focused on the distribution and differences within and between study groups by year of enrollment.

Persistence status is determined each year after entry. The categories are (1) not enrolled, (2) enrolled, and (3) enrolled and graduated. After persistence status is determined for each year, the financial aid package in the previous year is examined. The first category of financial aid data focuses on the type of package. The package classifications are (1) no aid (recorded at the institution), (2) gift aid only (grants, tuition waivers and scholarships), (3) self-help aid only (loans including PLUS loans [the federal Loans for Parents program] and federal work-study), and (4) combination package (including at least one gift award and one self-help award). Additional information included the total aid amount, the amount of gift and loan awards, and the total indebtedness for each yearly package.

Data Limitations. There are two important limitations to the data. The first involves the lack of persistence and financial aid data in years 7 and 8 for later cohorts. In year 7, data is only available for the 1989-90 and 1990-91 cohorts, and for year 8, only the 1989-90 cohort. Additionally, the number of enrolled or graduated students begins to drop off, leaving very small numbers in each cell for statistical analysis. This problem also is encountered in earlier years when the distribution of enrollment status by type of financial aid package is examined by gender and ethnicity for SEM majors.

The second limitation involves the 1992 reauthorization of the Higher Education Act. Changes in federal student financial aid definitions, need calculations and funding programs due to the reauthorization in 1992 should impact the financial aid packages and dollars starting in 1993-94. Figure 1 groups the cohorts pre- and post-reauthorization by year of aid package. This diagram serves as the basis for which cohorts are included in a statistical analysis of significance.

Figure 1 Effects of the 1992 Reauthorization of the Higher Education Act on the Study Cohorts by Year of Aid Package



NOTE: The financial aid received by cohorts within the circles were grouped for analysis to control for possible effects of changes in regulations and programs from the 1992 reauthorization of the Higher Education Act.

The circles in the diagram indicate which cohorts are grouped together and tested for significance. For example, in second year aid packages, three cohorts (1989, 1990 and 1991) are

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similar in that the packages are based on pre-reauthorization rules. Including the 1992 cohort in significance testing for year 2 may bias the results. Therefore, the 1992 cohort is excluded from the test. In the third year packages, the 1989 and 1990 cohorts were grouped and tested together (pre-reauthorization) as were the 1991 and 1992 cohorts (post-reauthorization). Grouping and testing the cohorts in this manner controls for the potential bias due to reauthorization.

Research Findings

This research study explores the student financial aid and academic success of underrepresented minority students, women students, and needy students, especially those majoring in science, engineering or math. The persistence and graduation findings for the various special populations are reported first, followed by the financial aid findings.

Persistence and Graduation Findings

The first research question asks, what are the persistence patterns of the study groups compared to peer groups at the institution? Unlike many persistence studies that measure persistence on the basis of fall term enrollment, enrollment in either fall or spring term measures annual persistence in this study. A student may stop out and re-enter in later years and is counted as persisting in the year of re-enrollment. To facilitate analysis, weighted cohort persistence averages were computed to compare differences in the enrollment patterns of the study groups. Since the student population at the study institution is large and fairly homogenous, aggregating the data in this manner should not introduce bias.

The first persistence is that the departure rates within science, engineering and math are the highest for underrepresented minorities and needy students. Approximately one third of underrepresented minorities and needy students did not re-enroll in the second year. The large second year drop is consistent with previous research for all freshmen regardless of major,

ethnicity or need (Pascarella & Terenzini, 1980; Porter, 1990). This finding reinforces the critical need for early intervention programs, orientation programs and seminars designed for freshmen in general, and special assistance programs designed for at-risk populations in science, engineering and math.

Another major persistence finding is that the departure rates for all SEM study populations compared to their counterparts in nonscientific majors was lower for each of the first five years. SEM students, however, spend more years enrolled and graduate at a slower rate than nonscientific majors do. This longer time-to-degree pattern for science, engineering and mathematics majors needs to be considered when packaging financial aid at the institutional level and at the national level when establishing financial aid programs. Another impact of longer time-to-degree is lost income. Each additional year in school represents a delay in entering the labor force. This increases the true economic cost of the SEM degree to the student.

Within science, engineering and math, Whites, Asians and females graduated at a faster rate. White and Asian SEM students are twice as likely to graduate in four years compared to underrepresented minorities. In Porter's 1990 study of college attainment rates by ethnicity for all majors, Whites and Asians were twice as likely to graduate in six years compared to Blacks and Hispanics (p. viii). In this study, female science, engineering and math students are twice as likely to graduate in four years compared to males, although males close the graduation rate gap in later years. This gender pattern is similar to those reported in BPS for all majors (NCES, 1996, p. 212).

Financial Aid Findings

The next three research questions focus on how the study populations finance their education, the association of the types of financial aid packaging with persistence, and the changes in the amounts of total aid, gift aid, loans and debt over time.

Financing the Cost of Education. Are students in the study groups financing higher education differently than their counterparts? For this analysis, the distributions of the type of aid packages were compared for significant differences using chi square tests. As noted in Figure 1, comparisons only are made among study cohorts whose packages were awarded under the same Higher Education Act rules. Table 2 summarizes the differences in the distribution of aid packages for five years by highlighting the comparisons that are statistically significant. The shaded areas reflect where significant differences in packages occurred. The lack of significance among so many comparison groupings indicates that financial aid criteria were applied consistently among the study populations. The most frequent significant difference in type of aid was by ethnicity. For the first five years, underrepresented minorities in both scientific and nonscientific majors were less likely to finance their education with gift aid only or self-help only packages. This finding confirms Porter's 1986 study at the same institution that found minorities, especially in their first year, participate in more types of aid. This finding also supports the prevailing theory that minorities are disproportionally represented in the lower income brackets, and therefore, eligible to participate in more financial aid programs.

A second significant finding was that, for the first three years, male SEM majors consistently received a larger proportion of gift aid only packages compared to males in nonscientific majors. This finding may be due to better academically prepared males (more likely to receive merit-based gift aid) being more inclined to enter science, engineering or math.

For students entering as nonscientific majors, females were more likely to have gift aid only packages and fewer self-help only packages than males during the first two years. This difference in packaging may reflect the likelihood of the strongest academically prepared males to enter science, engineering and math, while the similarly talented females select a non-scientific major.

Table 2 Significance in the Distribution of Aid Packages Among Study Groups (df=2)

Comparison Groups	1st Year	2nd Year	3rd Year Prior	3rd Year Post	4th Year	5th Year
SEM Majors to Nonscientific Majors	NS	NS	NS	χ^2(n=1354) =9.389	NS	NS
Minorities to Whites & Asians in SEM	χ^2(n=1178) =34.314	χ^2(n=562) =8.507	χ^2(n=365) =8.528	χ^2(n=329) =16.391	χ^2(n=498) =13.390	χ^2(n=497) =21.793
Minorities to Whites & Asians in Nonscientific Majors	χ^2(n=3208) =54.293	χ^2(n=1493) =37.175	χ^2(n=894) =16.781	χ^2(n=1025) =53.953	χ^2(n=1442) =81.405	χ^2(n=1265) =55.829
Minorities in SEM to Minorities in Nonscientific Majors	NS	NS	NS	NS	NS	NS
Whites & Asians in SEM to Whites & Asians in Nonscientific Majors	NS	NS	NS	χ^2(n=1013) =6.191	NS	NS
Females to Males in SEM	NS	χ^2(n=562) =12.776	NS	NS	NS	NS
Females to Males in Nonscientific Majors	χ^2(n=3208) =25.129	χ^2(n=1493) =15.560	NS	NS	NS	NS
Female SEM Majors to Female Nonscientific Majors	NS	NS	NS	NS	NS	NS
Male SEM Majors to Male Nonscientific Majors	χ^2(n=1996) =7.114	χ^2(n=897) =7.403	χ^2(n=558) =7.009	χ^2(n=601) =7.073	NS	NS

= p values at $\alpha < .05$ or significant

= not significant (NS) at $\alpha < .05$

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In three cases, significance in packaging did not follow a steady pattern over the five years and are more difficult to explain. Two of the cases occurred in third year packages received by the 1991 and 1992 cohorts. These packages were awarded under the 1992 reauthorization rules and may reflect institutional adjustments to the new regulations.

Type of Financial Aid Package and Persistence. The third research question examines whether the distribution of students by enrollment status significantly varies by the type of financial aid package received in the previous year. The initial intent was to conduct this research for each of the 16 study groups. The output, however, revealed too many cells (more than 20 percent) with low expected values. (For example, for each year of packaging, there were too few cases of underrepresented minorities majoring in SEM who received self-help only packages when sorted by two persistence categories. This problem also was evident for female SEMs with self-help only packages.) Therefore, this study could only examine the financial aid packages and persistence by entering major. Two of the chi-square tests for third year packages of SEM students also had low expected values, but the minimum expected counts in both cases were well over 1 and limited to one cell (16.7 percent of the cells). The smaller number of cases in third year packaging is due to separating third year packages into pre- and post-reauthorization groups (to control for the 1992 reauthorization of the Higher Education Act).

This analysis includes students who were enrolled, received financial aid and did not graduate in the year in which they received the aid package. The categories for financial aid packages are (1) gift aid only, (2) self-help aid only, and (3) combination packages (including both gift aid and self-help aid). Persistence categories for the following year are (1) not enrolled, and (2) enrolled or graduated. As shown in Table 3, significant differences were found in the likelihood of second year enrollment by type of financial aid package received in the first year

for both SEM and nonscientific majors. SEM majors also experienced differences in third year enrollment status by second year package type and in fourth year enrollment by third year packages awarded prior to the 1992 reauthorization of the Higher Education Act.

In each of these four cases, a higher proportion of students with gift aid only packages persisted the following year. This finding supplements numerous previous studies over many years reporting higher persistence and graduation rates for students receiving various forms of gift aid (Astin, 1975; Thomas, 1986; Carroll, 1987; Rendon & Nora, 1988; St. John, 1989; Porter, 1990). Students of both majors with self-help aid only packages during year 1 had the lowest percentage of students returning in the second year. The negative impact of first year loans on second year persistence also was reported by Astin (1975) and by St. John (1989) for loan only packages during the first three years of higher education.

Table 3 Significance in the Distribution of Persistence Status by the Type of Financial Aid Package Received in the Previous Year

	1st Year Package	2nd Year Package	3rd Year Package Prior	3rd Year Package Post	4th Year Package
Science, Engineering and Math Majors	χ^2 (2,n=1178) =9.335	χ^2 (2,n=562) =14.951	χ^2 (2,n=360) =7.433	NS	NS
Nonscientific Majors	χ^2 (2,n=3208) =32.788	NS	NS	NS	NS

= p values at $\alpha < .05$ or significant

= not significant (NS) at $\alpha < .05$

The positive association between gift aid only packages and the persistence in the subsequent year of SEM majors continues for the second and third year packages. SEM majors with combination packages in the second and third years had the highest proportion of students not re-enrolling in the subsequent year. This last finding differs from St. John's 1989 study for all majors that found combination packages of grants and loans had a positive effect for the first three years.

Trends in Aid Dollars. The final research question asks have the amounts and types of aid received by the study groups changed over time compared to more affluent students, nonminority students and male students? Since this research question explores changes in financial aid over the time of the study, each cohort is reported separately without grouping to isolate the impact of reauthorization. The percentage change in the average gift, loan and total aid dollars for each study group's package from the first cohort (1989) to the last cohort (1992) was calculated. This analysis was performed for the first five years of aid, as the sixth year financial aid data is not available for the 1992 cohort. The results confirm numerous studies reporting rapidly escalating financial aid totals (e.g., College Board, 1996; Fenske, Porter & Dillon, 1997). This analysis, however, provides greater insight to what type of aid is increasing and for which groups of students.

Sizable increases in average total aid from the first cohort in 1989 to the fourth cohort in 1992 were expected and documented for all five years of packages (from a low of $422 to a high of $1660). For the year 1 and 2 packages, the average increases (e.g., $686 for nonscientific majors and $708 for SEM majors in year 1 packages) are attributed mostly to increasing gift aid (e.g., $516 for nonscientific majors and $565 for SEM majors in year 1 packages). Later aid increases, especially in the third and fourth year packages, are due primarily to increasing loans.

This finding confirms front-loading the early years' packages with grants and relying on loans in the later years is operational among these study groups.

The overall observations of increased gift aid in the earlier years, however, were not consistent among the various study populations. There were virtually no increases, and in some cases, decreases in average gift aid for underrepresented minority SEMs (0.1 percent in year 1 and –3.6 percent in year 2) and needy SEMs (-0.2 percent in year 1 and 1.6 percent in year 2) even though the average SEM gift aid award increased over 22 percent in both years 1 and 2. This is a troubling finding given the positive association between gift aid and subsequent year persistence. The percentage increases in average gift aid awards for non-needy SEM majors were consistently higher than for the total SEM population in each year of packaging (e.g., 65.6 percent in year 1 and 53.0 percent in year 2). Therefore, it appears that much of the growth in gift aid was distributed on the basis of academic merit versus need.

For nonscientific majors, underrepresented minorities and needy students posted larger percentage gains in average gift aid than their peers in scientific majors but far below the gains of non-needy students in nonscientific majors. Percentage increases in average gift aid ranged from a high of 46.0 percent in year 1 packages to a low of 31.5 percent in year 5 packages for non-needy students in this category.

For the 1992 cohort, fifth year average debt exceeded $13,000 for both groups (increases of 57.8 percent for SEM majors and 45.2 percent for nonscientific majors). Within SEM, the annual percentage increases in average debt levels varied. Three study populations (needy students, Whites and Asians, and males) posted larger percentage increases in cumulative debt for the second through fifth year. Percentage increases in debt levels for underrepresented minorities in SEM were below average for all packages except in year 3. The smallest increases

in debt were found in the packages of non-needy students. For nonscientific majors, debt levels rose at a slower rate. The nonscientific study populations with the largest average increases in debt were underrepresented minorities, females, and needy students.

Contributions to the Field

The primary focus of this research is the persistence and financial aid of underrepresented minorities, women and needy students, especially those majoring in science, engineering and math. A major contribution of this work is the development of an institutional relational database that tracks students' academic progress and financial aid. This institutional database model can support a full array of institutional longitudinal studies.

The research findings of this study provide additional information on how science, engineering and math majors are financing their education, their persistence and graduation rates, and the type of packages associated most with persistence. These findings should be of value to student financial aid administrators, college retention specialists, and state and federal policy makers as they seek to improve access, retention and time-to-degree while also increasing representation in the technical labor force.

The findings of this longitudinal tracking study validated much of the earlier panel research. However, it is clear that the length of time special populations majoring in science, engineering and mathematics require to graduate is something future financial aid programs must consider. Also, it is clear that special populations are not participating in increases in gift aid to the extent of the other populations. This finding requires further research to ascertain the reason for the observed difference.

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